

PREFACE

This study is part of a continuing research program of the Agricultural Marketing Research Institute, designed to find more efficient and less costly systems for handling agricultural products from producer to consumer and to determine which system or systems best maintains the quality of the agricultural product.

Appreciation is expressed to all growers and packers of fresh tomatoes who made their facilities available and permitted researchers to measure and evaluate the various systems.

This work was done in the Market Operations Research Laboratory under the general supervision of John C. Bouma, Laboratory Chief.

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EVALUATING TWO SYSTEMS OF HARVESTING AND HANDLING FRESH TOMATOES

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ABSTRACT

Comparison costs to the packing plant for two harvesting and handling systems of fresh tomatoes determined the lowest cost system. System 1 included tomatoes harvested and handled in a 30-pound capacity fiberboard box (reusable approximately 4 times) from field to packing plant. System 2 included tomatoes harvested and handled in a 50-pound capacity wooden field box (reusable approximately 200 times) from field to packing plant. Costs were determined for harvesting tomatoes; field loading, transporting, plant unloading filled boxes; and reloading, and return of empty boxes to the field.

Total labor and equipment costs per ton were \$30.35 for System 1 and \$26.64 for System 2. Both labor and equipment costs at the plant were about the same for the two systems. However, the cost per box per trip was more than double for the fiberboard box (6.25 cents) compared with the wooden field box (3.0 cents).

In the Lower Rio Grande Valley of Texas, the packing plant usually contracts the harvesting by paying a harvesting foreman a fixed price to deliver fresh tomatoes to the packing plant. In this report costs were determined wherein the packing plant employed all the people necessary to harvest and handle the tomatoes. The total labor, equipment, and materials costs were below the prices (approximately \$40 per ton) that were being paid by the packing plants to the contract harvesting foreman for delivering fresh tomatoes to the packing plant.

If the packing plant employed the workers to harvest and transport fresh tomatoes, added indirect costs would be incurred for supervision, housing, equipment, bookkeeping, insurance, and other fringe benefits. These indirect costs added to the direct labor and equipment costs could make the cost per ton to harvest, transport, and unload fresh tomatoes at the packing plant more than the price paid to the harvesting foreman under the contract agreement.

KEYWORDS: Fresh tomatoes, systems, harvesting, handling, costs.

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INTRODUCTION

In the United States the tomato is a leading fresh market vegetable with an average (1976) annual production of over 2 billion pounds valued at \$425 million. Many tomato varieties are available for year round fresh market sale. These include cherry, round, and pear-shaped tomatoes in various shades of red or yellow. Those most commonly found in retail stores are pink or light red, round, and average about 3 inches in diameter.

Most commercially grown fresh tomatoes are harvested as either "mature green" or "breakers." A mature green tomato has a completely green skin but has reached the stage where the skin will turn red either on or off the vine. A breaker tomato in its first stage of changing color is primarily green with a tinge of yellow or pink, usually at the blossom end. Breakers are commonly termed "vine ripe" in the tomato industry. Mature green tomatoes and breakers are firm enough to withstand frequent handling during the marketing process and the time and travel necessary to get to market. Once mature greens or breakers are fully ripe, it is impossible to tell at which stage these tomatoes were harvested.^{2/}

In the Lower Rio Grande Valley in Texas, fresh tomatoes are usually harvested and transported to the packing plant under a contract agreement with a harvesting foreman. The foreman is paid an agreed amount of money per ton (approximately \$40 per ton) to deliver tomatoes to the packing plant. The harvesting foreman provides the labor and equipment needed to harvest the tomatoes and deliver them to the packing plant. At the packing plant the plant provides employees to receive, sort, package, and load out the fresh tomatoes. Labor, equipment, and material costs to receive fresh tomatoes at the plant are analyzed.

The purpose of this study was to determine requirements and costs of harvesting fresh tomatoes and delivering them to the packing plant, when the packing plant supplies all of the labor, equipment, and materials.

MATERIALS AND METHODS

The harvesting and handling operations in the field were the same in Systems 1 and 2. A picker, equipped with a canvas bucket, harvested the tomatoes by walking through the rows picking those ready for harvest (fig. 1). After his bucket was filled, the picker walked to the end of the row (fig. 2), emptied the bucket's contents into the boxes stacked for filling, and then returned to the field. The walking distance may be from a few yards to as much as 100 yards.

^{2/} Fahey, J. V. How fresh tomatoes are marketed. U.S. Dept. Agr. Mktg. Bul. No. 59, 1976.



Figure 1.--Picker harvesting tomatoes with partly filled canvas bucket nearby.



Figure 2.--The picker dumps the tomatoes from his filled canvas bucket into fiberboard boxes stacked for loading onto truck.

The differences in operation began when the tomatoes in the canvas bucket were emptied into either a fiberboard box (System 1) or a wooden box (System 2).

In System 1 a fiberboard box had a 30-pound capacity (4 useful trips per box) with outside dimensions of approximately 18 x 12 by 9 inches weighing approximately 2.4 pounds. The packing plant purchased these fiberboard boxes with overhanging tops from various produce wholesalers. The filled boxes were hand-loaded onto a truck (with sides) for transporting to the packing plant (fig. 3). After arrival the boxes were placed on a roller conveyor that led into the plant.

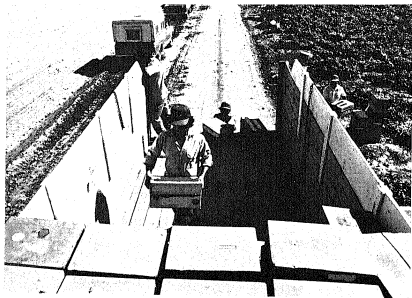


Figure 3.--Filled fiberboard boxes hand-loaded onto the truck for transport to the packing plant.

In System 2 a wooden box had a 50-pound capacity (200 useful trips per box) with outside dimensions of approximately 22 by 14 by 8 inches, weighing about 15 pounds. The filled boxes were hand-loaded onto a truck (without sides) for transporting to the packing plant. After arrival a two-wheeled handtruck unloaded the boxes and moved them into the plant.

Labor, equipment, and materials requirements and costs incurred by the packing plants were measured in man-hours, equipment-hours, and dollars per functions performed. The wage rates used in this report were \$4.50 per hour for fieldworkers and \$4.75 per hour each for drivers and plant workers. The equipment-hour requirements were converted to costs by using hourly ownership and operating costs developed in table 1 and box costs developed in table 2.

To measure the harvesting and handling operations with consistency, it was necessary to determine when the postharvesting movement to the packing plant ended and when the procedure in the packing plant began. The postharvesting movement ended when the tomatoes were removed from the truck at the packing plant.

For each harvesting and handling system, a model was constructed that included a typical size load, labor, equipment, and material requirements, and costs. The cost comparisons of the two systems are presented in a separate section.

RESULTS

One tomato picker required 4.76 man-minutes to pick tomatoes and fill his bucket, 0.53 man-minute to transport his filled bucket to a fiberboard box or a wooden field box and unload his bucket, and 0.49 man-minute to return to the field and resume picking. Total production time was 5.78 man-minutes per bucket. By using a 20 percent fatigue allowance, the total labor requirements per bucket were estimated at 6.94 man-minutes.

In System 1 one full bucket filled about 1.67 fiberboard boxes, with 550 boxes (16,500 pounds) constituting a truckload. By using a crew of 20 pickers, this yields a labor requirement of 38.17 man-hours per truckload for harvesting ($20 \text{ pickers} \times 1.9085 \text{ man-hours} = 38.17 \text{ man-hours}$).

When the fiberboard boxes were filled for a truckload, the men carried the boxes to a flatbed truck (with sides) for loading. A crew of four men loaded the truck (two men on the ground lifting the boxes onto the truck and two men on the truck stacking the boxes). Loading the truck required a total of 3.38 man-hours.

The loaded truck was driven from the field to the packing plants, which required a travel distance of less than a mile or several miles. At the packing plant two plant workers on the truck transferred filled tomato boxes to two plant workers on the ground who dumped the tomatoes into a trough (fig. 4). As the truck was unloaded, a roller conveyor was set up in the truck to help facilitate unloading (fig. 5).

Table 1.—Hourly ownership and operating costs for equipment required for two systems of harvesting and handling fresh tomatoes

System and equipment	Initial cost ^{1/}	Total fixed costs ^{1/}	Variable costs		Total variable costs	Total fixed and variable costs	Costs per hour of operation ^{2/}
			Power	Maintenance			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
System 1 (fiberboard boxes):							
Flatbed truck with sides	10,000.00(6)	2,366.67	3/600.00	4/1,000.00	1,600.00	3,966.67	0.930
Harvesting bucket	5.88(4)	1.88	—	—	—	1.88	.009
Roller conveyor	100.00(7)	21.29	—	5/1.50	1.50	22.79	.005
System 2 (wooden field boxes):							
Flatbed truck	9,500.00(6)	2,248.33	3/600.00	4/950.00	1,550.00	3,798.33	.889
Harvesting bucket	5.88(4)	1.88	—	—	—	1.88	.009
Handtruck	75.00(10)	12.75	—	5/1.12	1.12	13.87	.003

^{1/} Total fixed costs include straight line depreciation (estimated life in years in parentheses after initial cost), interest at 3 percent of initial cost or 6 percent of depreciated balance, and insurance and taxes at 4 percent of initial cost.

^{2/} Based on a total of 1,600 hours of annual operation for all equipment multiplied by 0.375 or 600 hours (3 months) equipment used for tomato operation. Harvesting buckets used 200 hours per month.

^{3/} Fuel costs calculated at \$200 per month for 3 months.

^{4/} Maintenance costs at 10 percent of initial cost.

^{5/} Maintenance at 1.5 percent of initial cost.

Table 2.--Box cost and total cost per trip

Type of box	Boxes needed per trip	Initial cost per box	Trips per useful life	Cost per box	Cost per trip
	<u>Number</u>	<u>Dollars</u>	<u>Number</u>	<u>Dollars</u>	<u>Dollars</u>
Fiberboard	550	0.25	4	0.0625	34.37
Wooden	300	6.00	200	.0300	9.00

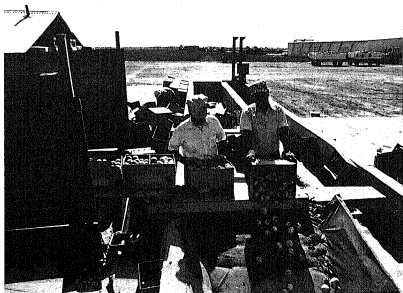


Figure 4.--Two workers dumping tomatoes into the trough at the packing plant.

The four-men crew took 3.78 man-hours and 0.93 equipment-hour to unload 550 filled boxes from the truck. Two plant workers reloaded the field truck with empty boxes requiring a total of 2.09 man-hours.

The trip for the truck from field to the plant required 0.18 hour based on 2 to 3 miles of travel, 0.94 hour to unload filled boxes, 1.04 hours to load empty boxes, and 0.18 hour to return to the field.

With System 1, the packing plant supplied a flatbed truck (with sides), 20 picking canvas buckets, and 550 fiberboard boxes for a total of 5.098 hours.

In System 2 one full bucket filled one wooden field box (fig. 6) with 300 field boxes (15,000 pounds) constituting one truckload. By using a crew of 10 pickers, this yields a labor requirement of 34.70 man-hours per truckload for harvesting (10 pickers X 3.47 man-hours = 34.70 man-hours).

When the wooden field boxes were filled for a truckload, the men carried the boxes to a flatbed truck (without sides) for loading (fig. 7). A crew of four men loaded the truck (two men on the ground lifting the boxes onto the truck and two men on the truck stacking the boxes). Loading the truck required a total of 2.23 man-hours.

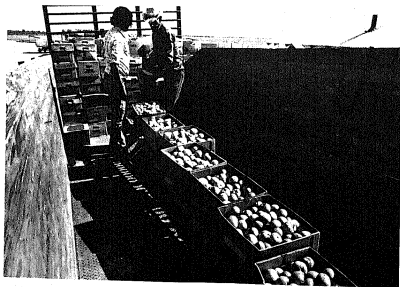


Figure 5.--Two workers placing filled tomato fiberboard boxes on the roller conveyor in the truck.



Figure 6.--Picker dumping tomatoes into wooden field boxes.



Figure 7.--Pilled wooden field boxes are loaded onto a flatbed truck.

The loaded truck driven from the field to the packing plant required a travel distance of less than a mile or several miles. To facilitate unloading at the packing plant, a man on the truck separated a column of boxes with a crowbar. A second man on the truck clamped onto the column of boxes with a two-wheel handtruck (fig. 8), which had a clamp attachment, and transported the load approximately 45 feet from the truck to the conveyor line in the plant. The total time to unload the truck was 1.39 man-hours and 0.86 equipment-hour.

A two-man crew reloaded the truck with empty wooden field boxes--the first man transporting the boxes with a two-wheel handtruck to the second man on the truck who stacked the boxes. The total time to reload the truck with 300 empty wooden field boxes was 2.40 man-hours and 1.10 equipment-hours.

The trip for the truck to the packing plant required 0.18 hour, 0.69 hour to unload filled boxes, 1.20 hours to load empty boxes, and 0.18 hour to return the empty boxes to the field.

With System 2 the packing plant supplied a flatbed truck (without sides) 10 picking canvas buckets, and 300 wooden field boxes for a total of 6.282 hours.

The results from these harvesting and handling systems in the Lower Rio Grande Valley of Texas can be applied to other geographic areas where similar systems are used.



Figure 8.--Filled wooden field boxes being transported into the packing plant.

COST COMPARISON OF THE TWO SYSTEMS

Plant labor and equipment costs for harvesting and transporting fresh tomatoes from field to packing plant with the two systems are presented in table 3.

Table 3.--Plant labor and equipment costs for harvesting and transporting fresh tomatoes from field to packing plant with two systems

Item	System 1 (fiberboard boxes, 16,500 pounds per truckload)	System 2 (wooden boxes 15,000 pounds per truckload)
Labor cost:		
Harvesting ^{1/} -----dollars-----	171.76	156.15
Transporting ^{1/2/} -----do-----	11.11	10.69
Packing plant ^{1/} -----do-----	27.88	18.00
Harvesting and plant equipment cost:		
Truck-----do-----	<u>3/</u> 4.74	<u>4/</u> 5.58
Harvesting buckets-----do-----	<u>3/</u> .50	<u>4/</u> .36
Fiberboard boxes (500)-----do-----	<u>5/</u> 34.37	--
Wooden field boxes (300)-----do-----	--	<u>5/</u> 9.00
Roller conveyor-----do-----	<u>6/</u> .01	--
Handtruck-----do-----	--	<u>7/</u> .01
Total labor and equipment cost:		
Per load-----do-----	250.37	199.79
Per ton-----do-----	30.35	26.64

^{1/} Wage rate per hour for field workers, truck drivers, and plant workers at \$4.50, \$4.75, and \$4.75, respectively.

^{2/} Costs include time to load truck, drive to packing plant, unload, reload empty boxes, drive to field.

^{3/} Equipment-hours per truckload were 5.098 for the truck and 55.07 for the harvesting buckets (hourly ownership and operating costs developed in table 1).

^{4/} Equipment-hours per truckload were 6.282 for the truck and 40.27 for the harvesting buckets (hourly ownership and operating costs developed in table 1).

^{5/} Box cost developed in table 2.

^{6/} Equipment-hour requirements per truckload was 0.93.

^{7/} Equipment-hour requirements per truckload was 2.06.

Equipment costs per ton were approximately the same for the two systems, but box costs were not (table 2). In System 1 the useful life of the fiberboard boxes was found to be about four trips; in System 2 life of the wooden boxes was found to be 200 trips. The box cost per trip (550 boxes) was \$34.37 for System 1 compared with \$9.00 per trip (300 boxes) for System 2. Cost per box per trip was more than double for the fiberboard box (6.25 cents) compared with the wooden field box (3.0 cents).

Both labor and equipment costs at the plant were very similar, \$3.38 and \$2.40 per ton for Systems 1 and 2, respectively. Most of the cost at the plant is for labor, with very little equipment involved.

Total labor and equipment costs per ton were \$30.35 for System 1 and \$26.64 for System 2. Supervisory time and costs were not included in the cost comparison, but if included such costs would increase the total cost \$2.00 or \$4.00 per ton for each system.

If the packing plant did employ the workers needed to harvest and transport the product, additional costs besides the direct labor and equipment costs would be incurred. These added costs would increase the total costs of the systems. Additional costs would result if the packing plant had provided housing for the harvesting crews and transport vehicles for moving the crop from field to plant. These extra workers would increase costs for supervision, equipment, and bookkeeping. Also, besides paying the extra workers' wages the packing plant would have to pay for the workers' fringe benefits, such as insurance and social security taxes. These indirect costs added to the direct labor and equipment costs could make the cost per ton to harvest, transport, and unload fresh tomatoes at the packing plant more than the price paid to the harvesting foreman under the contract agreement. For this reason, most packing plants have a contract agreement for the delivery of fresh fruit and vegetables to their plant.

